Endovascular Treatment of Cerebral AVM with Onyx - Initial Experience

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Summary

Five patients (M:2, F:3; Age range 9-51; N = 30 yrs) with cerebral AVM were managed with Onyx embolization through endovascular route in last three months. Two patients had complete occlusion of AVM following embolisation. In remaining three, one had 95% occlusion and other two had 70% and 50% occlusion respectively. No procedural related complications were observed immediately following procedure.

Introduction

Cerebral AVM is the most common intracranial vascular malformation with prevelance of roughly 0.02-0.05% of general population1. Patients with AVM have varying presentations including intracranial haemorrhages (50-70%), seizures (25-50%), headache, progressive deficits and steel syndrome [2].

Therapeutic alternatives include the following, either alone or in combination.
1) Operative resection or obliteration.
2) Endovascular embolization.
3) Radiosurgery. Earlier, embolization was done with histoacryl with wipe out rate of 15-30% in experienced hands. With the introduction of Onyx the new embolic agent the unique ability to percolate into nidus cure rate has been increased to 30-50% and now Grade III, Grade IV, AVM become amenable for endovascular treatment. Now in this article we present our initial experience of treatment of AVMs with Onyx.

Patients and Methods

Between December 2004 - March 2005, Five patients (M:2, F:3; Age range 9-51; Mean 30 yrs) with cerebral AVMs were treated with Onyx (table I).

The diagnosis of AVM were established by CT, MRI and finally DSA.

Methods

After the preprocedural investigations endovascular treatment of AVM with Onyx were performed under general anaesthesia. The procedure was performed in 3D Rotational DSA equipment (Bi plane GE ADVANTX LCN+ Milwaukee GE Medical System USA) with online subtracted and un subtracted fluoro and acquisition review capabilities. The duration of the treatment was varied from 2 hrs - 4½ hrs. Super selective catheterization of AVM nidus was performed using DMSO compatible ultraflow microcatheter with Mirage wire combination and embolic agent was Onyx 18 (ev 3 international, Plymouth, MN). Care was taken to place the microcatheter in the nidus or very close to the nidus in the wedge position. DMSO 0.25 ml was slowly injected in one minute prior to the injection of Onyx to fill up the dead space. The Onyx was injected very slowly

Table 1 **Clinical Summary of 5 Patients Undergoing AVM Embolisation with Onyx**

Pt.No.	Age/Sex	Clinical features	Angio diagnosis	Complications
1.	49/M	IVH	Corpus callosal AVM	Nil
2.	19/M	Seizures	Left temporal AVM	Nil
3.	51/F	Seizures,headache, mental impairment	Left temporal AVM	Nil
4	46/F	Haemorrhage, focal deficit	Left motar strip AVM	Nil
5	9/F	Headache,LOC,IVH	Left medial paratrigonal AVM	Nil

Table 2 **Angioarchitecture and Embolization Details**

	Nidus Size	Feeders on Angiogram	Nidus Morphology	Venous Drainage	Feeders Embolized	Result
1.	4.5 cm	• Lt. pericallosal • Post pericallosal • Medial posterior choroidal	• Compact • Intranidual aneurysm+ • Enpassage feeders	Deep system	Pericallosal artery	70%
2.	3.5 cm	• Temporal branches of MCA	• Compact • No intranidal aneurysm	Superficial system	Temporal branches of MCA	100%
3.	10 cm	• Lt. medial and lateral posterior choroidal • Posterior temporal branches of PCA • Inferior division of MCA • Anterior Choroidal	• Compact • Intranidal aneruysm	Superficial and deep system	Posterior temporal and Posterior choroidal	50%
4.	4 cm	• Temporal branches of MCA	• Compact • No intranidal aneurysm	Superficial middle cerebral veins to Covernous sinus	Temporal branches	100%
5.	3.5 cm	• Medial and lateral posterior choroidal	• Compact • No intranidal aneurysm	Superficial	Medial and lateral posterior choroidal	95%

and progressively taking care of the venous filling and avoiding reflux along the feeding artery. The injection was stopped for 30 seconds when any of these two events were observed and continued to inject till complete filling was achieved. The end point of the injection were [1] Complete filling of the nidus [2], Progressive reflux inspite of adequate waiting period [3], Absence of filling of nidus [4], Elapse of more than 45 mts in the single feeder. Post embolization angiograms were obtained and results were evaluated. All patients were observed in critical

care unit for next 24 hrs and discharged after 3-5 days.

Results

Initial angiographic results revealed total embolization with complete obliteration of the nidus in two patients. In one patient near total obliteration was achieved. In another patient embolization was only partially achieved because of enpassage feeders and the patient was referred for surgical resection. In another patient with Grade IV AVM 70% obliteration of the nidus was achieved and is waiting for the embolization for the remaining feeders. One patient had features of disconnection syndrome due to the previous haemorrhage and continued to have the same in the post procedural period. No complications were encountered during or immediate post procedure period or in this short follow up. Patient who had aphasia and hemiplegia improved over a period of three months.

Representative Cases

Case 1: 49-year-old male patient presented with repeated episodes of intraventricular bleed with features of fibre disconnection syndrome. 4 Vessel angiogram revealed left corpuscallosal AVM fed by left pericallosal artery, posterior pericallosal and medial posterior choroidal artery. Using ultraflow/mirage combination the left pericallosal artery was catheterized and embolization was performed. A large portion of the AVM and intranidal aneurysm was embolized. Patient remained stable, however no improvement in neurological status observed.

Case 2: 19-year-old student presented with history of seizure. CT and DSA done revealed left temporal lobe AVM fed by temporal branches of MCA and drainage into superficial venous system. Three of the left MCA feeders were catheterized and embolization performed using 2.6ml of Onyx which was injected over period of 90 minutes. Complete embolization was achieved.

Case 3: 46-year-old female patient had one episode of LOC for 5minutes followed by aphasia and right hemiplegia. CT done revealed putamen bleed. DSA revealed a left motor cortex AVM supplied by temporal branches of MCA. Hyperselective catheterization of AVM nidus was done and onyx embolisation performed. 3.5 ml of oOnyx was injected into two feeders, each injection lasting for 40 and 45 minutes. Complete embolization was achieved. Patient recovered from neurological deficit gradually.

Discussion

Management of intracranial AVM is a therapeutic challenge for the neurologist, neurosurgeons, neuroradiologists or gamma knife therapists. Although surgery is the definitive mode of therapy in cerebral AVM, location within the eloquent areas, inaccessible site, involvement of different arterial territories offer significant problem to the surgeons. Gamma knife / X Knife therapy is an elegant way of managing this lesion again limited by the presence of recent bleed, AVM with intra nidal fistula and intranidal aneurysm with propensity to rebleed soon. The tumor seedlings along the radiotherapy portals years later the radiation necrosis were the major limiting factors.

Endovascular management of cerebral AVM was began in early 1980's with the avaialability of flow guided catheters. Prior to this free flow embolization was performed with dismal results. Various embolic agents were tried in this connection with varied results. Particulate agents were used in selected centers as a preoperative revascularization technique [3]. Recanalisation was the rule when embolized with particulate agent. Total obliteration of the AVM could be achieved by endovascular embolization using NBCA with results varying from 15 to 30% depending on the centers experience. Results of the total wipe out with endovascular embolization was better in small Grade I / Grade II AVM. In Grade III or Grade IV AVM attempt to achieve obliteration resulted in more complications. Improvement in catheter technology permitted to navigate the catheter into the nidus and better results were achieved to the tune of 25-35% in well experienced hands. Recanalisation of totally obliterated AVM is unknown with NBCA, although rare instances were reported in literature [4]. Endovascular embolization was limited in instance for preoperative embolization or reducing the nidus size prior to radiosurgery or gamma knife therapy.

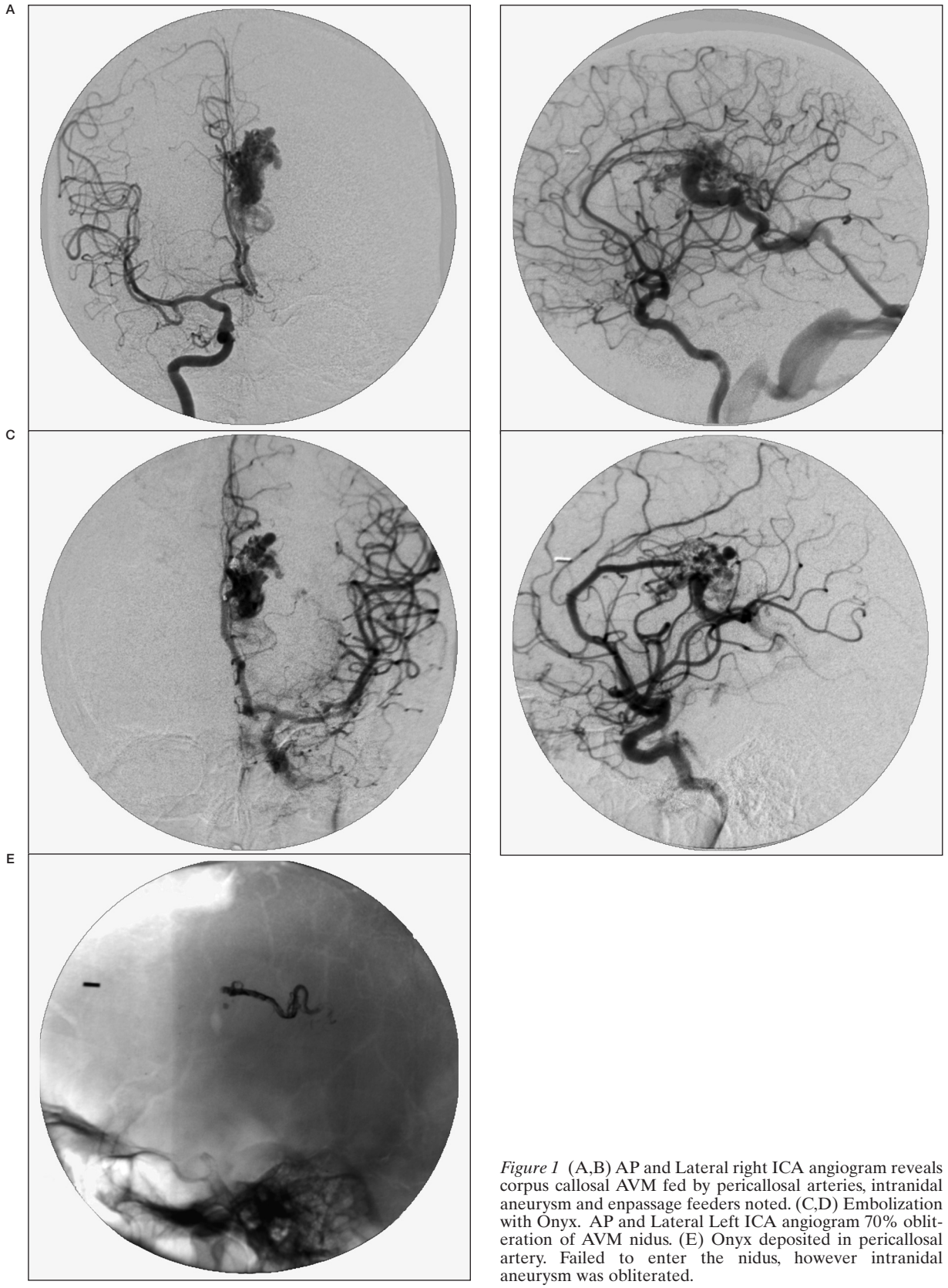

Figure 1 (A,B) AP and Lateral right ICA angiogram reveals corpus callosal AVM fed by pericallosal arteries, intranidal aneurysm and enpassage feeders noted. (C,D) Embolization with Onyx. AP and Lateral Left ICA angiogram 70% obliteration of AVM nidus. (E) Onyx deposited in pericallosal artery. Failed to enter the nidus, however intranidal aneurysm was obliterated.

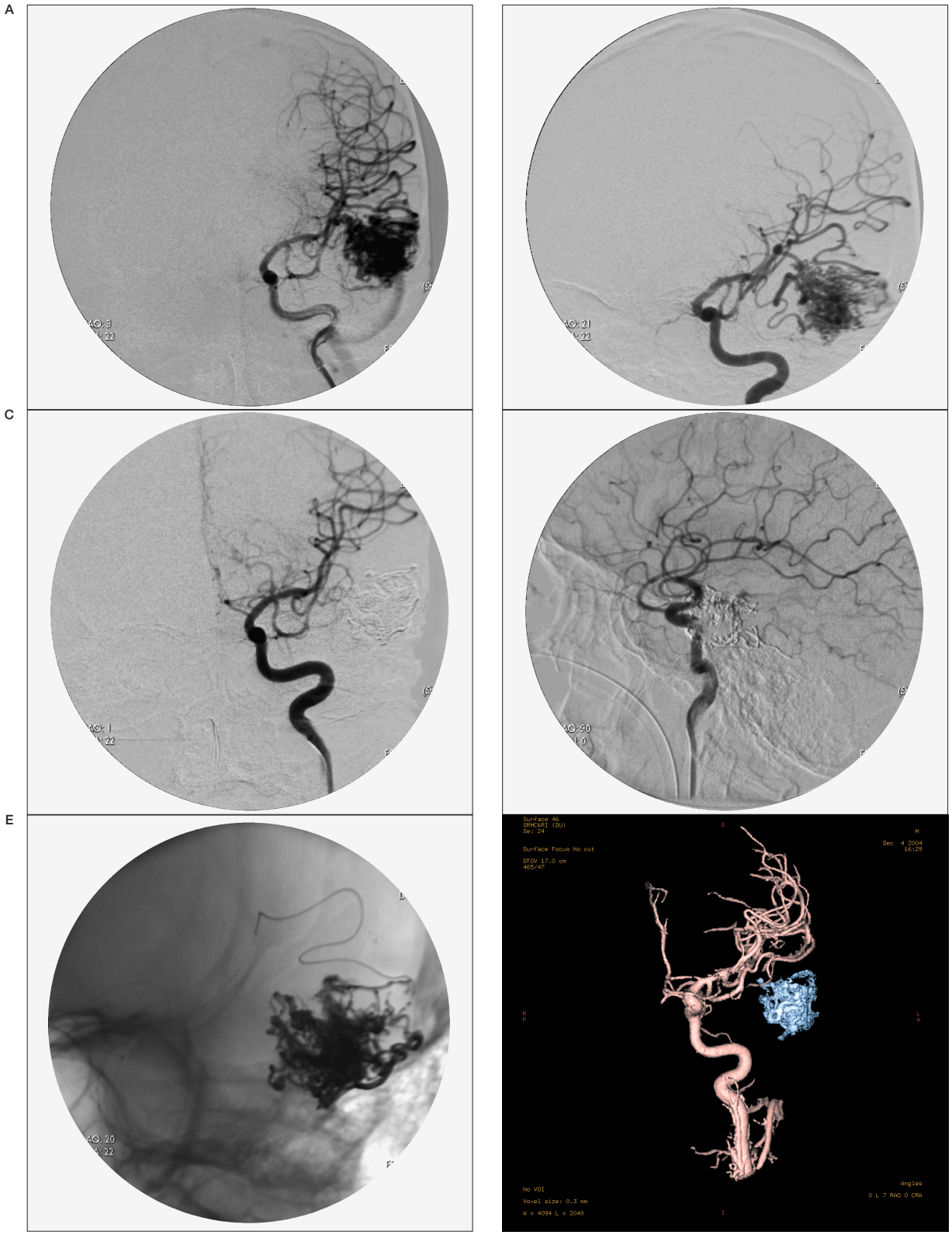

Figure 2 (A,B) AP and Lateral Left ICA angiograms reveals large temporal lobe AVM fed by MCA. (C,D) Embolization with Onyx. AP & Lateral Lt. ICA angiograms complete obliteration of AVM nidus. (E) Depositied Onyx cast. (F) Post embolization 3D angio with Onyx cast.

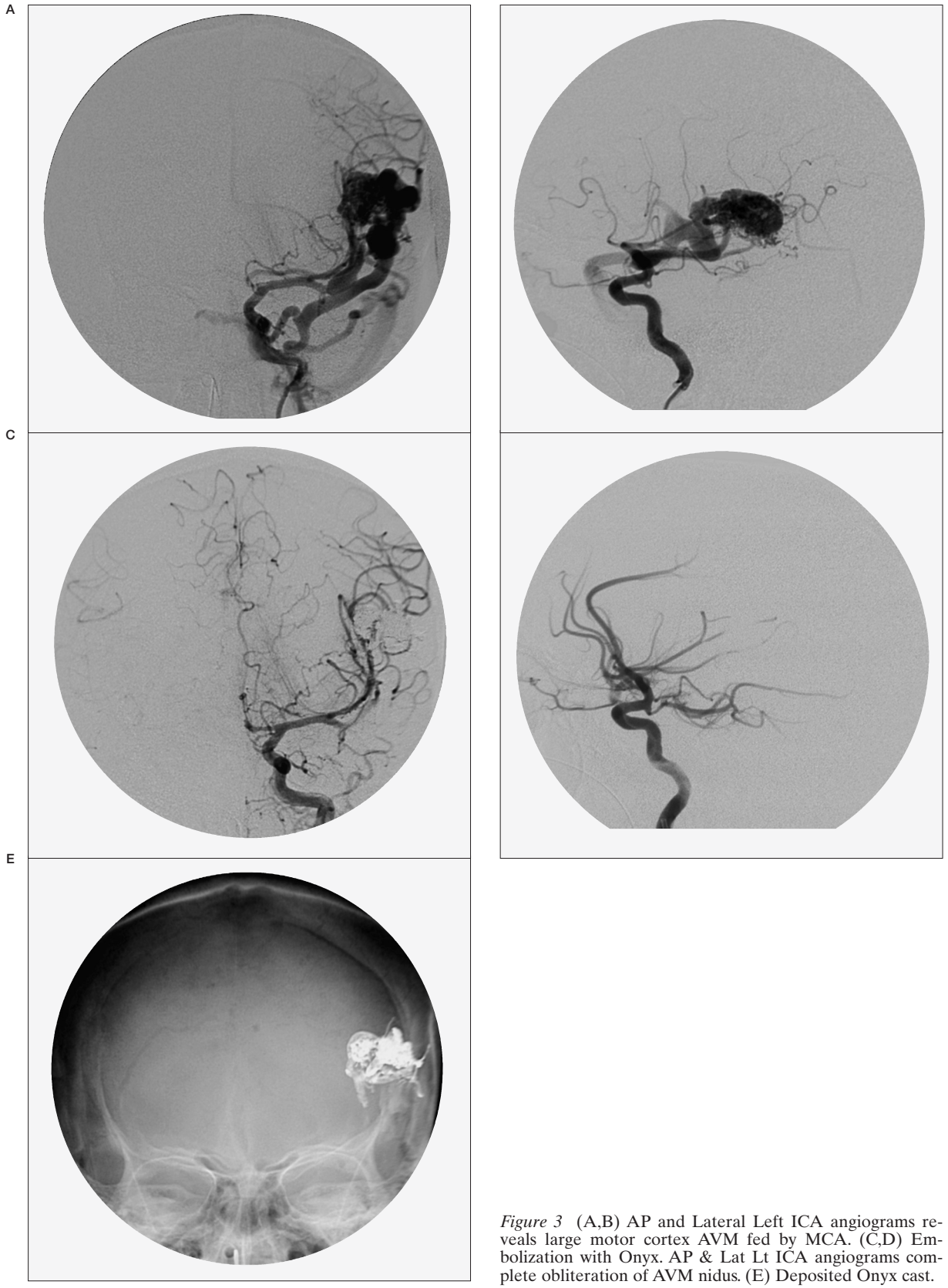

Figure 3 (A,B) AP and Lateral Left ICA angiograms reveals large motor cortex AVM fed by MCA. (C,D) Embolization with Onyx. AP & Lat Lt ICA angiograms complete obliteration of AVM nidus. (E) Deposited Onyx cast.

Onyx as an embolic agent for cerebral AVM was started in mid 1990's and has matured enough to get the desired results in experienced hands [5]. Onyx is a non adhesive liquid embolic agent called as EVOH dissolved in DMSO with micronized tantalum to produce radio opacity. When DMSO evaporates, the EVOH polymerizes and precipitate to form solid gel like material resulting in obliteration of the nidus. The ability of the Onyx to penetrate into the nidus without the running the veins unlike NBCA make it one of the unique embolic agents in the management of intracranial AVM. Since it is non adhesive material, there is less chance of gluing of microcatheter. However, reflux along the microcatheter proximally should be limited to 1-1.5 cms for safe retrievability of microcatheter. The wipe out rate of AVM by endovascular embolization using onyx significantly enhance and ranges from 40-60% in selected centeres in the experienced hands.

However good imaging equipments with capabilities of live unsubstracted and substracted fluoro, simultaneous acquisition and review capabilities is essential to achieve these results.

In this short series of 5 patients treated with onyx two patients had total obliteration. The third patient near total 98% obliteration was achieved. But due to the post operative feeder status complete penetration of the nidus was not possible. In patient with "en-passage" feeders Onyx did not penetrate into the nidus. Onyx penetrates only partially and resulted only 70% obliteration of the nidus and subsequently send for surgical resection. In a patient with multi compartmental AVM with large size AVM, with posterior cerebral and MCA feeders, the vulnerable area associated with posterior cerebral artery was initially used for embolization. The remaining feeders were stayed to avoid normal perfusion break through phenomenon.

Experience in embolizing AVM with glue was extremely beneficial for us to obtain better results with use of Onyx. Although there was no major or minor complication related to the procedure careful and strict adherence to the guidelines are extremely important to obtain the optimal outcome.

Further long term results and follow up angiogram can only substantiate the initial and continued results. However, the initial results with the use of Onyx seems to be impressive and encouraging.

Conclusion

Considering the natural history of AVM, with cumulative haemorrhage rate of 3-4% per year, the goal of management of these lesions should be a complete obliteration. Earlier embolization was employed as preoperative or intra-operative adjunct to definitive surgical excision or radiosurgery. But with Onyx a higher rate of definitive therapy is possible. The use of onyx allows a curative embolization and a high nidal occlusion. Multiple penetrations of Onyx into the nidus from same catheter position reduces the number of feeders to be treated. The angiographic and clinical results confirm this method as a safe treatment option for intracranial AVM.

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